

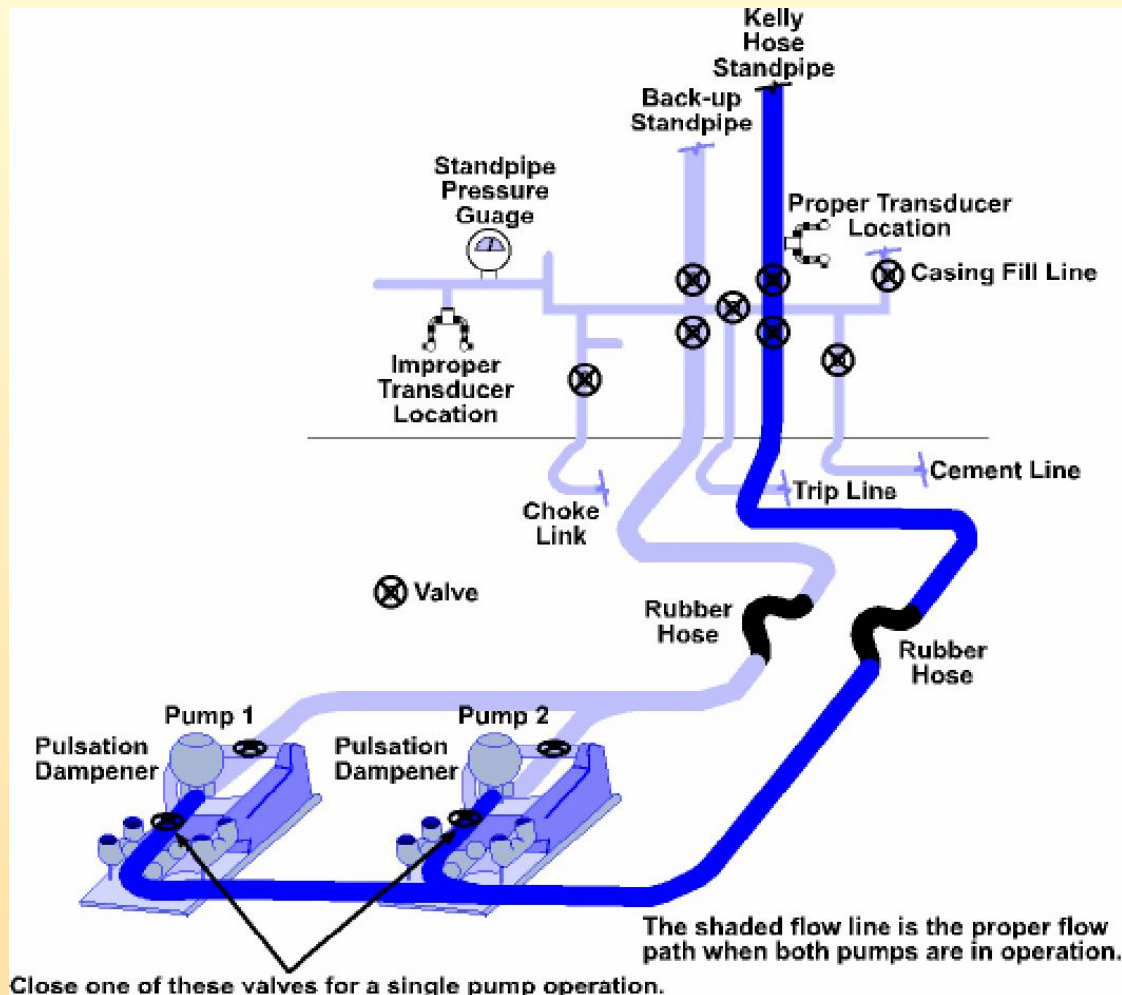
LWD 1

Encoding & Decoding

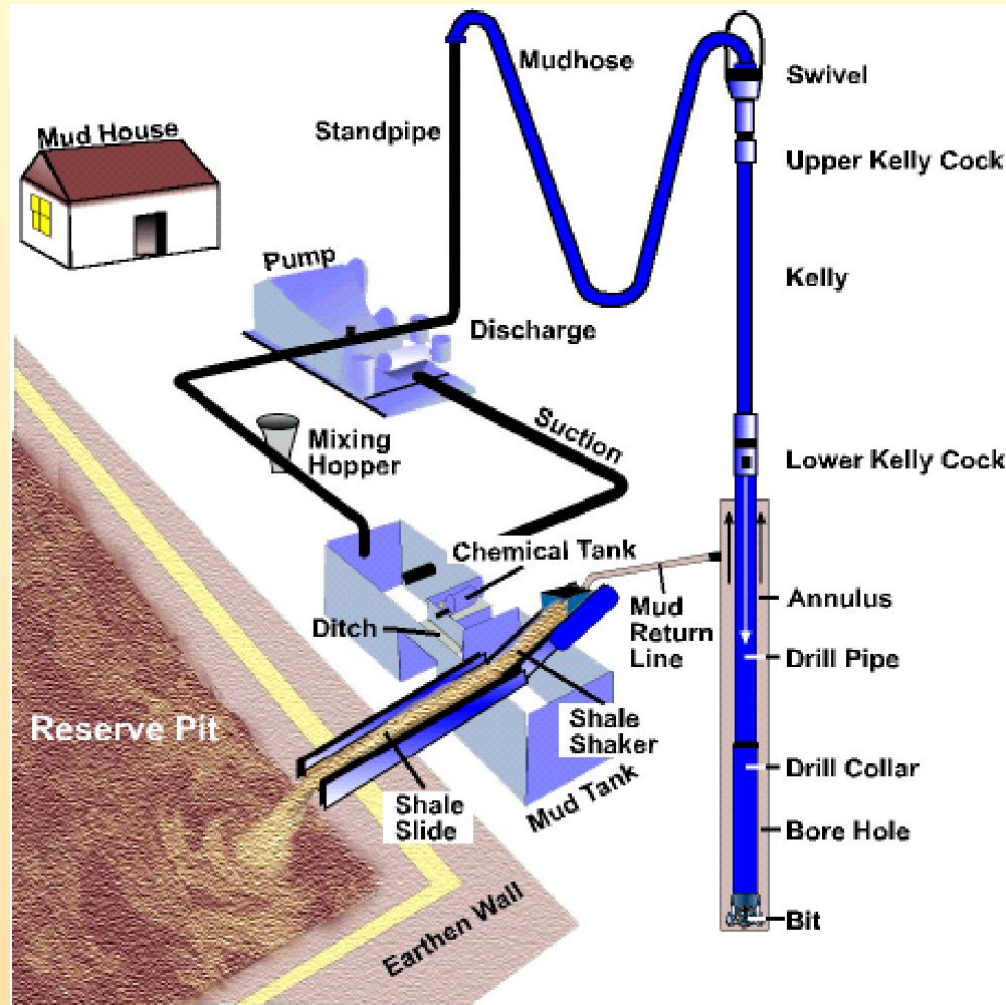
TRANSMISSION SEQUENCE

- Flow begins
- Probe is powered up
- 30 second warm up period
- Running pulses start
- Probe controls the solenoid to actuate poppet
- Poppet restricts flow area creating a positive pressure
- Pulse is transmitted at about 4000 ft/sec
- Pulses are measured by the transducer and encoded by the surface computer via the barrier box

MUD CIRCULATING SYSTEM



MUD CIRCULATING SYSTEM

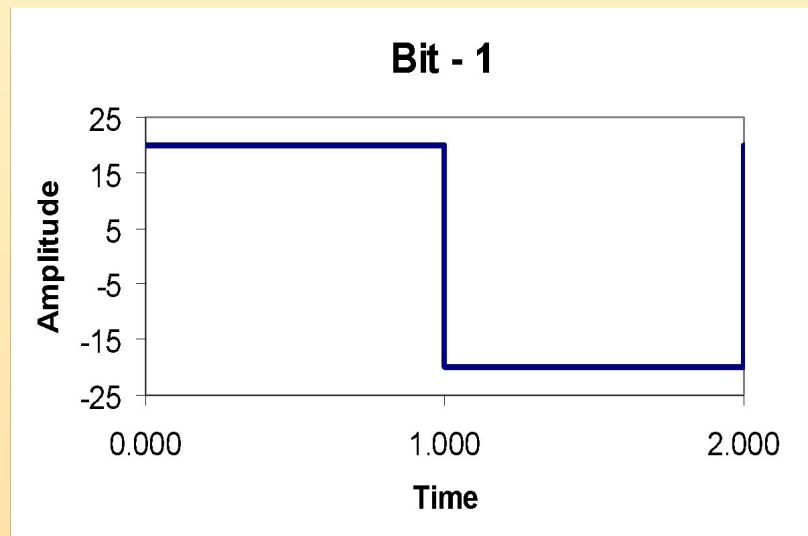
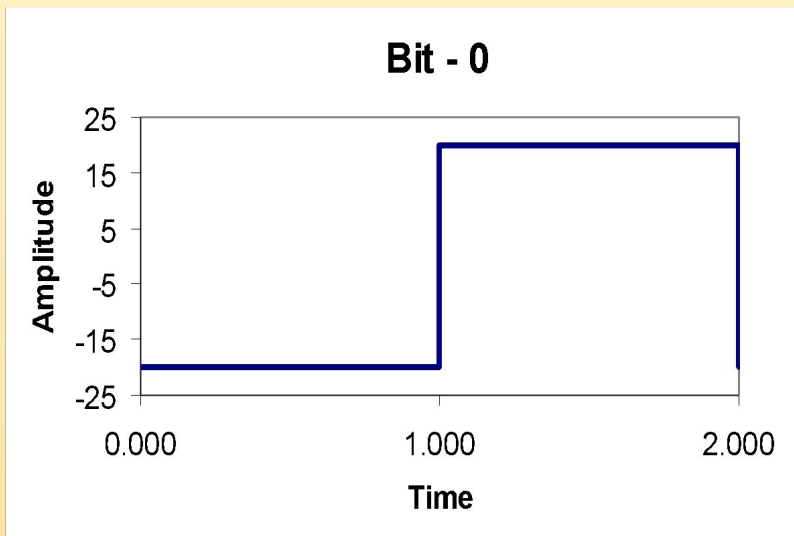


DATA ENCODING / DECODING

- **Encoding:**
 - Manchester (more reliable)
- **Decoding:**
 - Algorithm M12 (NEW)
 - Algorithm Double Level Threshold (DLT)

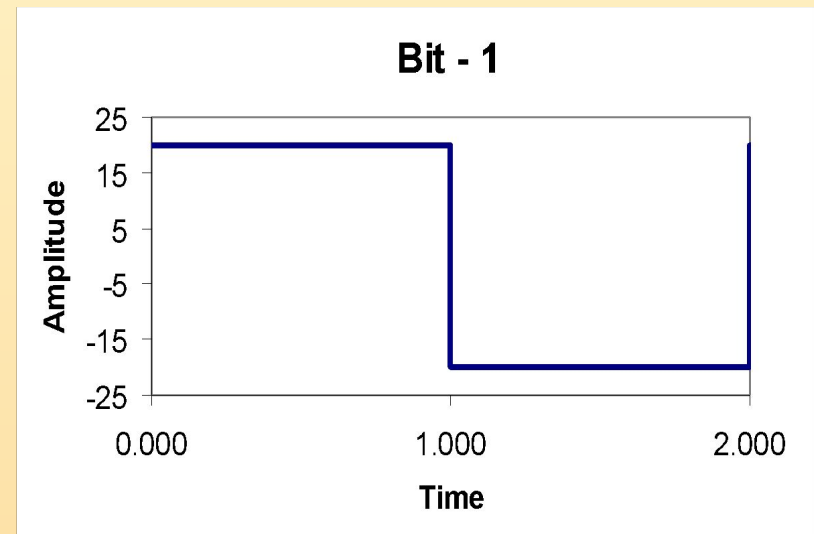
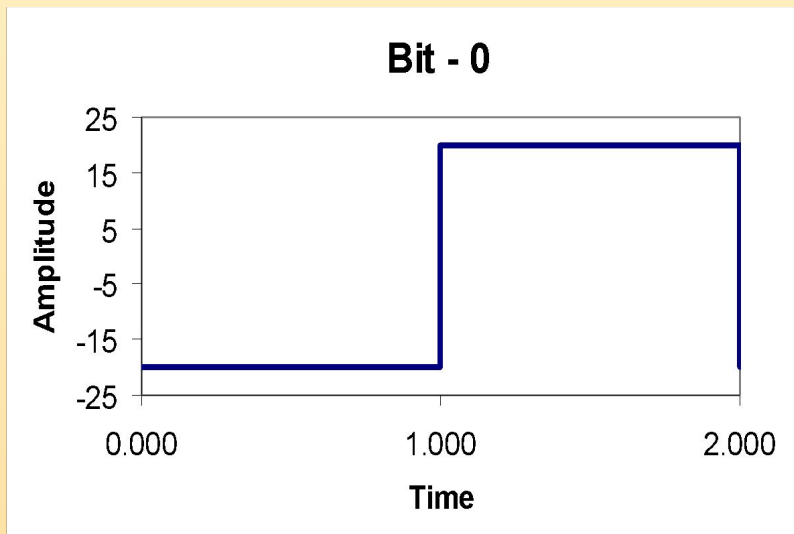
Manchester Encoding

- ◆ Encoding is how the data is written
- ◆ It Defines 0's & 1's with positive pulse pressure surges.



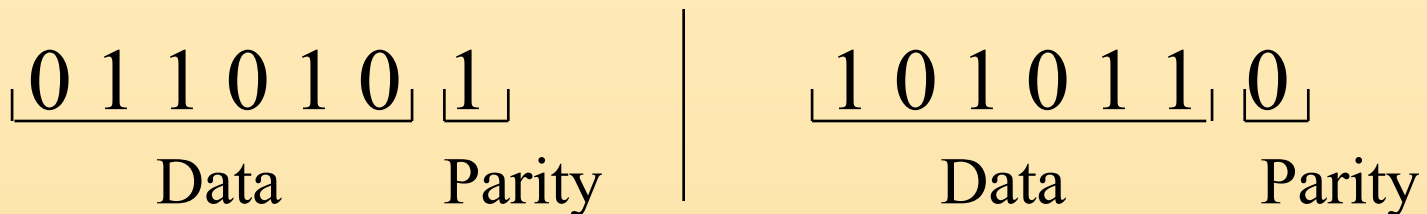
BIT

- ◆ Smallest Piece of Information
- ◆ Either data bits or parity bits
- ◆ Bit is either 0 (Low to High) or 1 (High to Low)
- ◆ Like letters of alphabet (,b,c,...)



WORD

- ◆ Word is a piece of information (Inclination, Azimuth, toolface, etc)
- ◆ Made of 5 Bits (shortest) up to 13 Bits (longest)
- ◆ Word contains data bits **and** one even parity bit.
- ◆ Parity bit will be added Downhole before transmitting the word to be valid for detection.
- ◆ Parity Bit will be **0** if the number of 1's in data bits is devisable by 2, otherwise it will be **1**.
- ◆ Word is valid for encoding only if passed parity check.

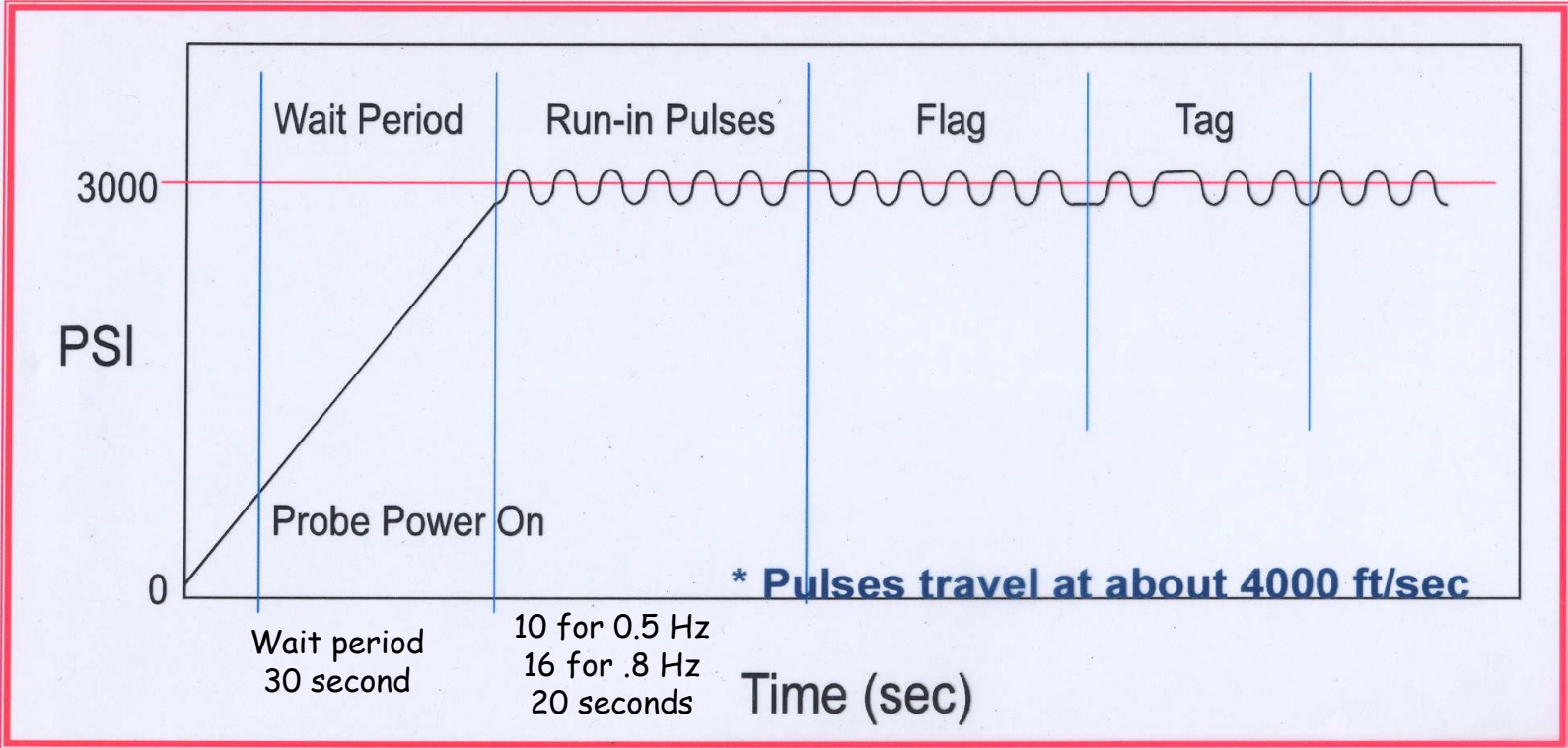


Even parity: Sum of 1's in a word is an even number

BLOCK

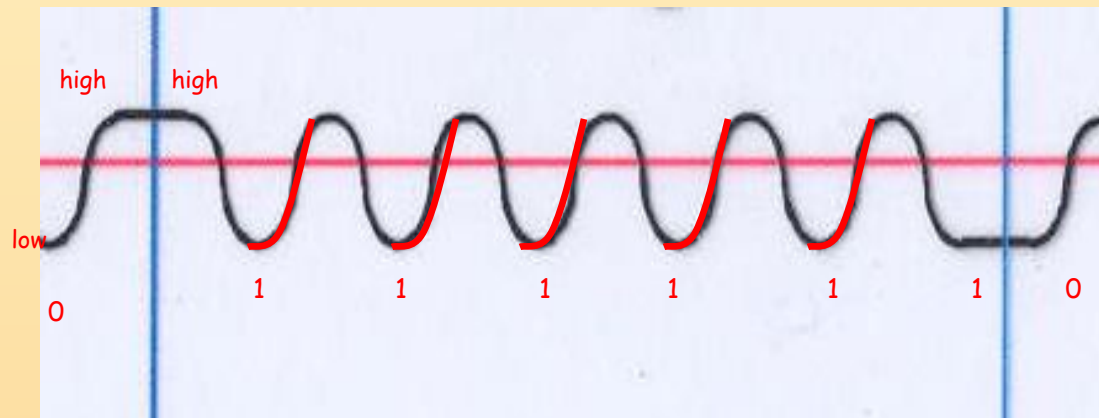
- **A group of words in a specific sequence**
 - (i.e. Survey, Toolface list)
- **Always Begins with a Flag/Tag Sequence**
 - **Synchronizing Surface Computer with probe**

TRANSMISSION SEQUENCE



Flag

- ◆ Synchronizes surface computer with down hole probe.
- ◆ Made up of 0 1 1 1 1 1 0 (double high, 5 short pulses and double low).
- ◆ Surface computer halts pervious detection, identify new block start.
- ◆ Defines the start of decoding (0's & 1's) as all the running pulses are zeros (10 for 0.5 Hz & 16 for 0.8 Hz).
- ◆ Begins decoding new tag.



Tag

- ◆ Used for block Identification.
- ◆ Contains 5 bits, the first is used to identify toolface type : 0 for Magnetic & 1 for Gravity.

X	XXX	X
Toolface Type	Identity Data	Parity Bit

Toolface

- ◆ Contains 7 bits (six data bits + one parity bit).
- ◆ Toolface transmission time is 14 sec. At 0.5 Hz.
- ◆ Toolface transmission time is 8.7 sec. At 0.8 Hz.

FREQUENCY

$$\textit{Frequency(Hz)} = \frac{\textit{Cycles}}{\textit{Second}}$$

$$\textit{Transmission(Hz)} = \frac{\textit{Pulses}}{\textit{Second}}$$

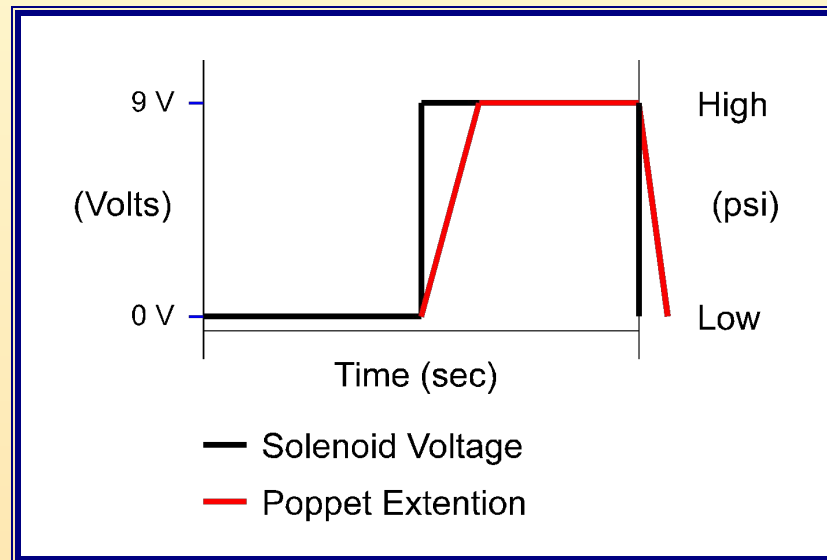
$$\textit{Data Rate(Hz)} = \frac{\textit{Bits}}{\textit{Second}}$$

Transmission Frequency

$$\diamond 0.5 \text{ (Hz)} = \frac{1\text{Pulse}}{2\text{Seconds}} = \frac{1 \text{ Bit}}{2\text{Seconds}}$$

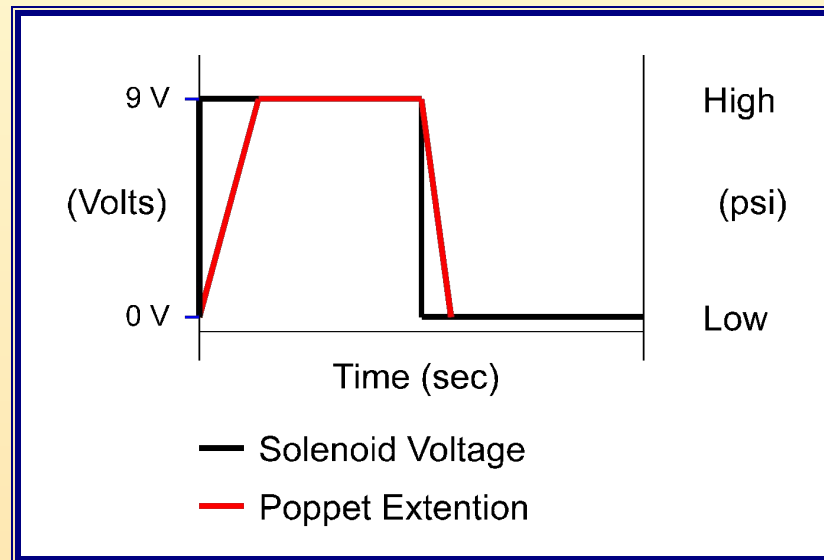
$$\diamond 0.8 \text{ (Hz)} = \frac{8\text{Pulse}}{10\text{Seconds}} = \frac{1\text{Pulse(Bit)}}{1.25 \text{ Seconds}}$$

MANCHESTER ENCODING



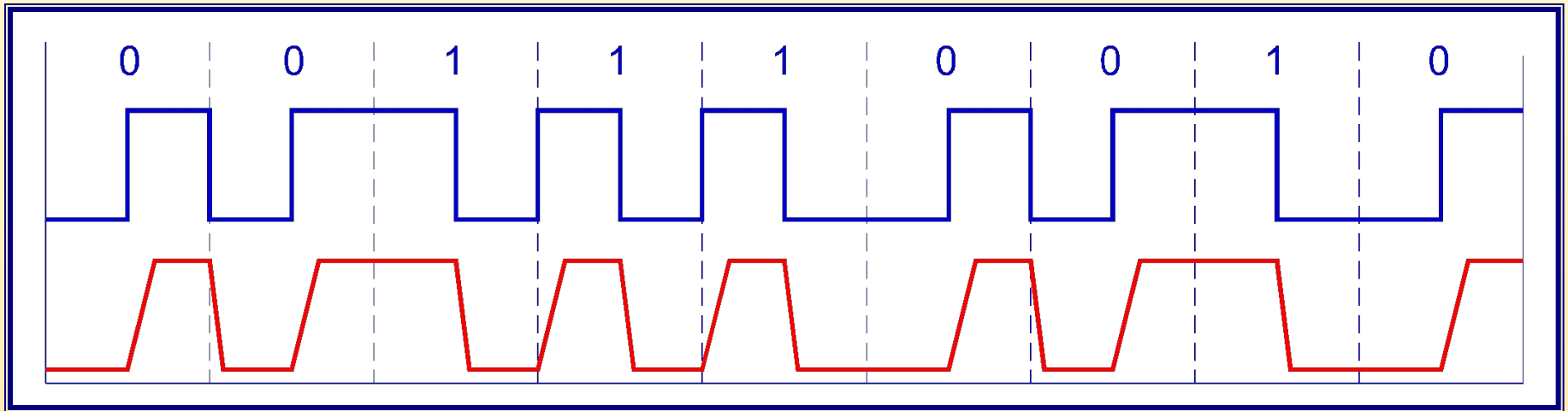
Low to High Pressure Change (Voltage) Represents a “0”

MANCHESTER ENCODING



High to Low Pressure Change (Voltage) Represents a “1”

MANCHESTER EXAMPLE



Solenoid
Poppet Extention

Decoding Schemes

◆ Detection Algorithms are :

- Algorithm Double Level Threshold (DLT)
- Algorithm M12 (Mean 12- new)
- Manchester Max (Modified M12)

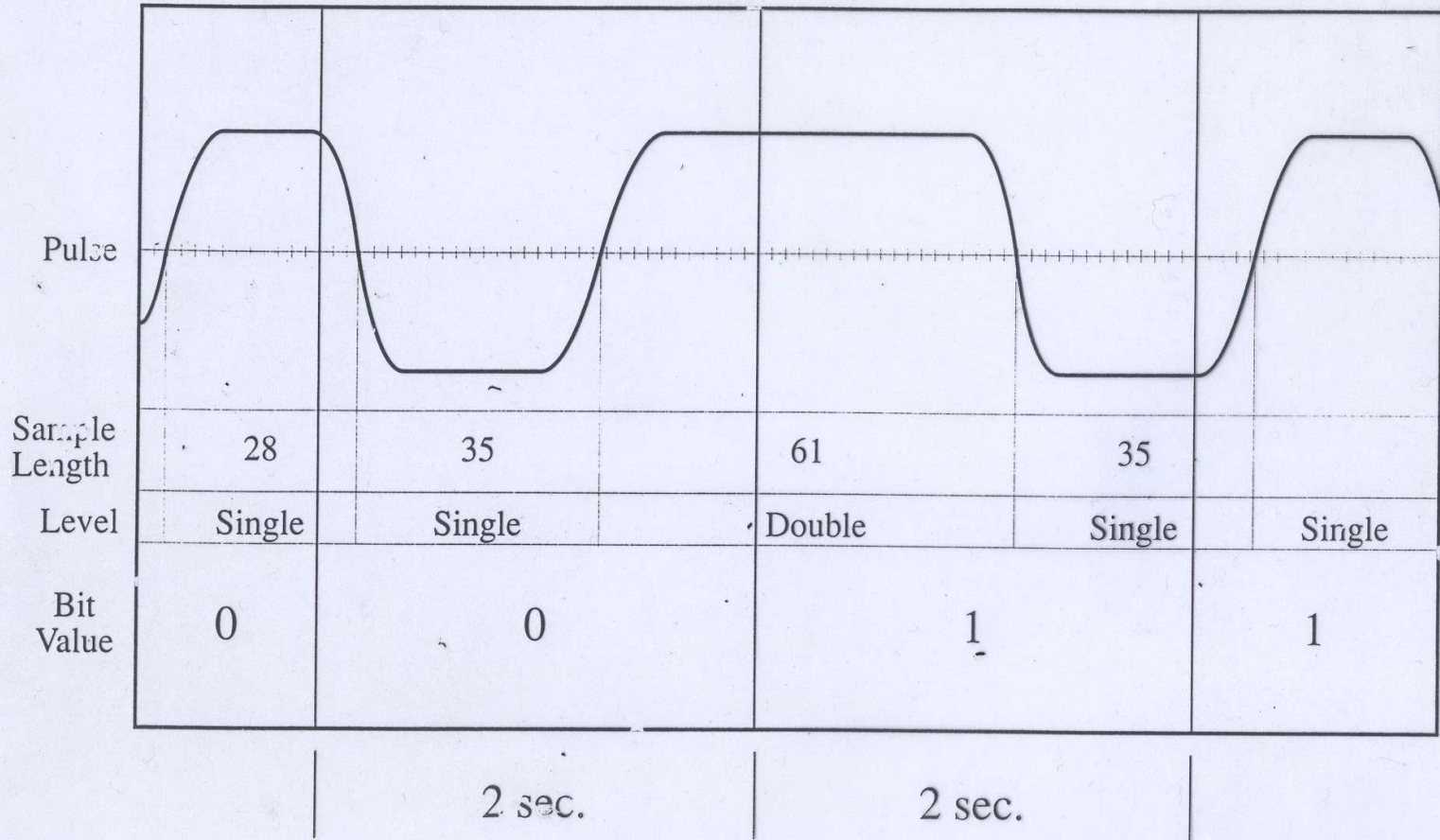
Decoding Schemes

Algorithm Double Level Threshold (DLT)

- ◆ Not a filter but a decision making tool.
- ◆ Looks at length of pulse to determine long and short pulses.
- ◆ Pressure signal is sampled 64 times per bit,
Short Pulse < 48 > Long Pulse
- ◆ Long pulse means change :-
 - Long High means change from 0 to 1
 - Long Low means change from 1 to 0So pulses before or after can be sorted.

D. L. T.

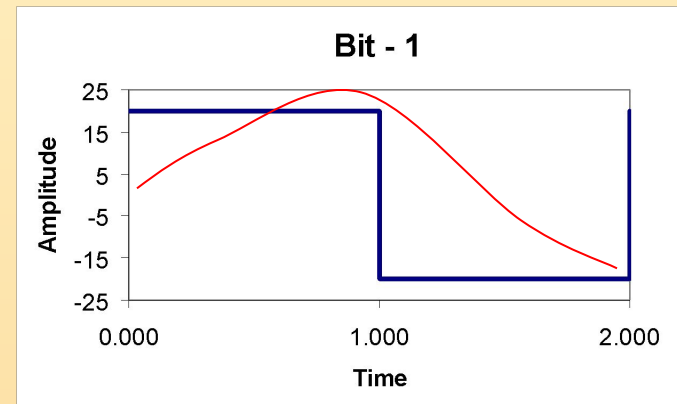
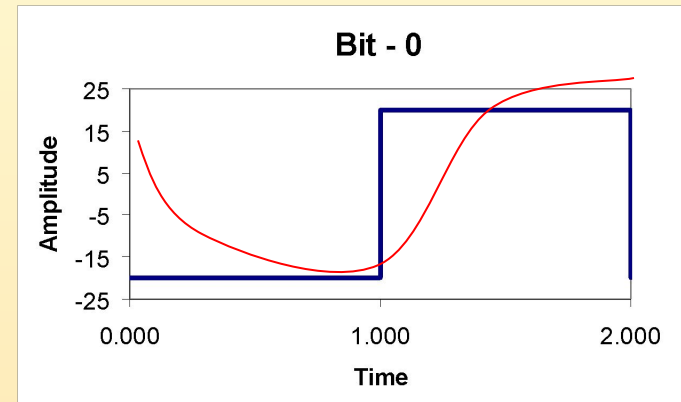
1 Division = $\frac{1}{16}$ sec.



Decoding Schemes

Algorithm M12 (new)

- Evaluates the pulse by looking at the slope change during the second half.
- A positive slope is a “0”
- A negative slope is “1”
- it is helpful when receiving too many reflections.



Transmitted Surveys

FULL SURVEY

•Probe transmits

- Gx
- Gy
- Gz
- Bx
- By
- Bz
- Dmt

•Surface computer calculates

- Inclination
- Raw Azimuth
- Absolute Azimuth
- Gtotal
- Btotal
- Dip
- Az_{a-r}

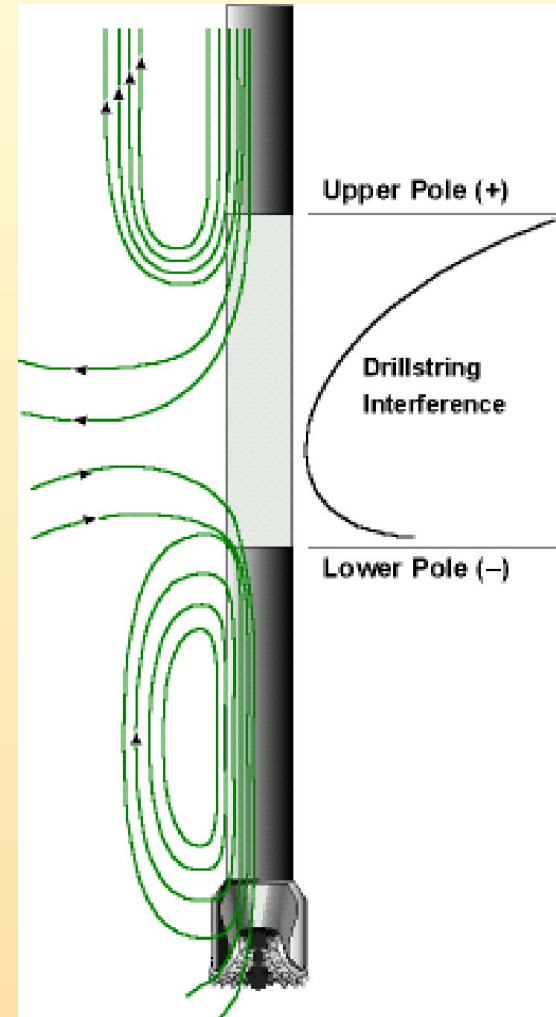
Transmission time is about 2.5 times longer than Short Survey

SHORT SURVEY

- **Probe transmits**
 - Inclination
 - Raw Azimuth
 - Gtotal
 - Dmt
- **Short Collar Solution CANNOT be used**
 - Probe must be properly spaced in NMDC
- **No magnetic interference present**

Note: Short survey is best used when experiencing detection problems

DRILL STRING INTERFERENCE



SHORT COLLAR SOLUTION

- **Corrects azimuth for magnetic drill string interference**
 - **Bz is corrupted**
- **Mathematically iterates a Bz using theoretical DIP and Btotal**
- **Calculated downhole or surface computer**
 - **DEPII/PCD/DM**

SHORT COLLAR LIMITATIONS

- **Cannot correct for cross-axis magnetic interference**
- **Need accurate DIP and B_{total} for location**
- **Must have accurately calibrated probes**
- **Must have stable sensor readings**

Probe Operations

Directional Only Modes

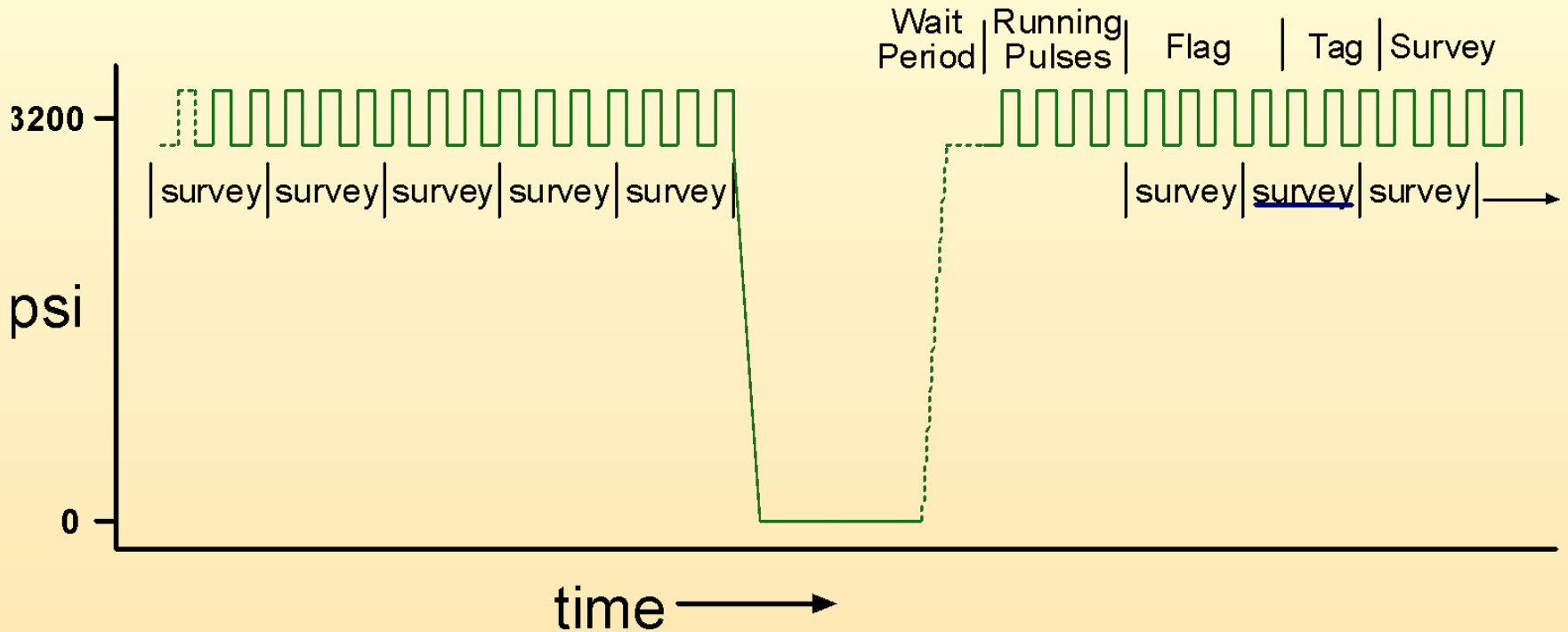
- ◆ **Steering Modes :- 1, 2, 4, 5, 6, 8**
 - **Used with steerable BHA**
 - **Will transmit surveys and toolfaces continuously**

- ◆ **Survey Only Modes :- 3, 7**
 - **Used with rotary BHA**
 - **Will only transmit three surveys then cease pulsing**

Pumps Up Steering Survey

- **Available with Modes 1, 2, 4 or with PU Tag(CDS)**
- **Survey sampled and stored during transmission of second TF**

Pumps Up Rotary Survey



- Available with Modes 3 & 7 or with PU Tag(CDS)
- Survey sampled and stored during transmission of Tag.

Pumps Down Survey

- **Available with Modes 5-8 or with PD Tag(CDS)**
- **Drill string is held still for 60 sec. before turning pumps off**
- **Survey is sampled and stored 20-25 sec before pumps off to avoid reactive torque.**

Pumps Off Survey

- **Survey taken with battery in Modes 5-8 with PD Tag**
- **Survey sampled and stored 30 sec. after pumps off**
- **Drill string is held still 45 sec. after pumps off**

Custom Data String CDS Mode(PCD,DEPII)

Configure and Download

Transmission Parameters | LIST 1 | LIST 2 | SRS | Slim Phase 4 Recorded | DDS | PWD | SLD | ABI | CTN | WOB

Transmission Parameters Setup

General parameters

Data Rate 1

Data Rate 2

Wait Period (15-90 secs)

Run-In Period (15-90 secs)

Error Alarm Transmission Period (1-60 min)

Toolface Magnetic to Highside Switch (0.0-16.0 Deg. 0 for HS only)

Survey parameters

Current borehole azimuth

Current borehole inclination

Wellsite latitude (deg.min)

Telemetry type

Data Rate 1

Data Rate 2

Download Mode

CDS Mode

Configure and Download

Transmission Parameters LIST 1 LIST 2 SRS Slim Phase 4 Recorded DDS PWD SLD ABI CTN WOB

Preamble Loop

ROP 1000.00

	Secs/Sample		Samples/Ft		Max ROP @ 1 Sample/Ft	
	0.50	0.80	0.50	0.80	0.50	0.80
EWR-Extra Shallow	0	0	0.000	0.000	0.000	0.000
EWR-Shallow	0	0	0.000	0.000	0.000	0.000
EWR-Medium	0	0	0.000	0.000	0.000	0.000
EWR-Deep	0	0	0.000	0.000	0.000	0.000
Gamma	0	0	0.000	0.000	0.000	0.000
Temperature	0	0	0.000	0.000	0.000	0.000
Toolface	0	0	0.000	0.000	0.000	0.000
Inclination	0	0	0.000	0.000	0.000	0.000
Short Collar Azimuth	0	0	0.000	0.000	0.000	0.000
Long Collar Azimuth	0	0	0.000	0.000	0.000	0.000

Double-click list items to send to list

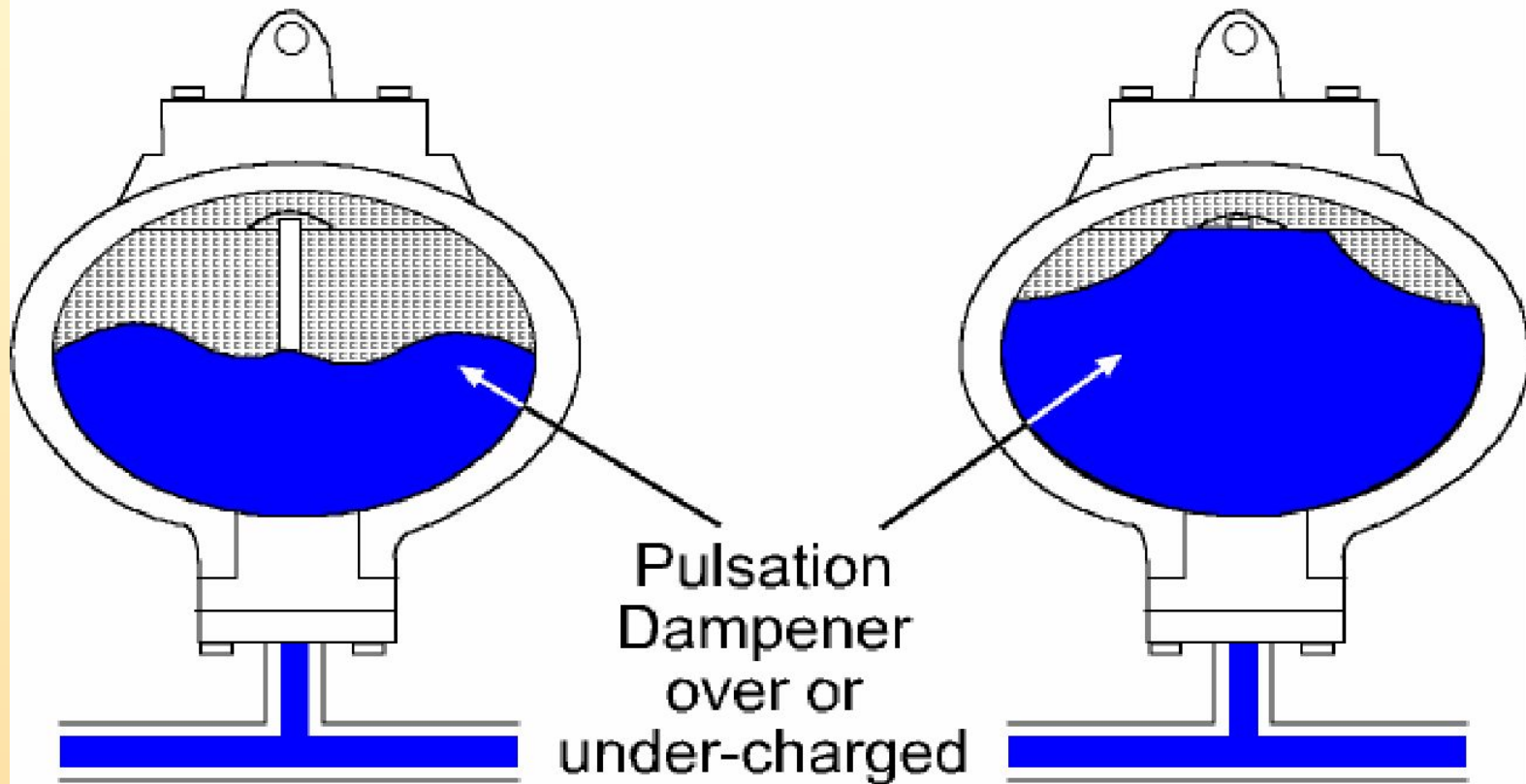
Flag condition

- PD Pumps Down
- PU Pumps Up
- Directional Parameter IDs
- GX GY GZ Gravity vectors
- BX BY BZ Magnetic vectors
- RM Impeller rpm
- TM Probe temperature
- TF Automatic Toolface
- IN Downhole Inclination
- SC Downhole Short Collar Azimuth
- LC Downhole Long Collar Azimuth
- GT Gravity Total
- HS Raw Probe Gravity Toolface
- BM Btotal measured
- BC Btotal calculated
- Gamma Ray ID
- GR Dual Gamma Ray
- Resistivity IDs
- XP Extra shallow phase EWR
- SP Shallow phase EWR
- MP Medium phase EWR
- DP Deep phase EWR
- TE SP4 temperature
- ABI IDs
- AI At Bit Inclination
- Battery IDs
- BS Bottom stroke

Download Update Detection OK Cancel Apply + Test Help

MUD CIRCULATING SYSTEM

DAMPENERS



MUD CIRCULATING SYSTEM

